VILNIUS GEDIMINAS TECHNICAL UNIVERSITY

Mindaugas Gikys

INTERNET-BASED REAL ESTATE MULTIPLE CRITERIA DECISION SUPPORT SYSTEM

Summary of Doctoral Dissertation
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VILNIAUS GEDIMINO TECHNIKOS UNIVERSITETAS

Mindaugas Gikys

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Relevance of the research

In Lithuania, the real estate market has been growing fast in recent years. Such a speedy rise in the country‘s real estate market is being affected by several main factors: residents see the broad lending possibilities; the improving economic situation gives people greater hopes and expectations; the indices of available housing in Lithuania still lag behind the EU almost twice; once the demand well exceeds the supply, good conditions open to the construction companies and real estate agencies to sell their production; the expanding real estate market attracts investments from people who have free money; growing inflation in the country; etc.

Due to the market expansion and higher competition, integration of information technologies to the real estate sector is more necessary today than ever before. The application of information technologies and telecommunications in the real estate sector ensures faster exchange of information among all interest groups, and allows more effective responding to market changes.

Today we find internet as the field of applying information technologies and telecommunications in the real estate business. With the help of internet in any activity, the possibilities are provided to overcome time and space. By using internet, we can freely get a sufficiently big amount of exhaustive information about real estate. However, today‘s possibilities provided by internet are not limited to this. Frequently, different websites on real estate give us a possibility to take advantage of the business expert consultancies, advice, expert evaluations, etc. Also, very often, internet enables us to use different real estate e-business systems that make it possible to engage in purchase and sale of products, services and information, communication with partners, concluding transactions on-line or other maintenance of business by way of using on-line infrastructure.

Currently, a great deal of real estate e-business systems is available throughout the world. These real estate e-business systems provide information and some services in the following areas: real estate sales, purchase, lease, various search, diverse pieces of advice and information on real estate lease and its planning, comprehensive information about deposits, credits, insurance services, settling in a new place, experienced tenant advice for beginners, leasing services, information about moving to a new residence, buildings’ administration services, different kind of classifieds, other cognitive information, etc.

Today, you can find all comprehensive information about real estate and its environment in the most progressive e-business systems or real estate Multiple Listing Services so that system users can get all desirable information using their computers. The following real estate services are

provided by the mentioned real estate e-business systems: real estate search, review of insurers‘ services, analysis of insurance service options, automated geographic information system services, real estate object display through the electronic network, presentation of electronic promotional information about real estate, selection of potential buyers for security, for more secure real estate object sales, buildings’ administration services, assistance in negotiations on purchase-sales contracts.

With the recent rise of economy in Lithuanian, the real estate market has boosted up, and possibilities in applying information technologies and telecommunications seem to be getting higher, research of application of electronic systems in real estate sector becomes a key object of construction science.

Research Object

Research object includes application of intellectual Internet electronic systems in real estate sector.

Aim and Objectives of the Research

The main goal of research is to create an Internet-based Real Estate Multiple Criteria Decision Support System and render a theoretic model to the Lithuanian Real Estate Multiple Listing Service.

This goal provides us with the following objectives:

- To determine areas and forms for application of the intellectual internet-based electronic system in real estate sectors;
- To review intellectual internet-based electronic systems with applied neural networks, expert systems and decision support systems, applicable in worldwide real estate sector;
- To create an Internet-based Real Estate Multiple Criteria Decision Support System;
- To create and integrate an internet-based electronic real estate market value calculation subsystem in the Internet-based Real Estate Multiple Criteria Decision Support System,
- To create and integrate e-mail negotiations system in the Internet-based Real Estate Multiple Criteria Decision Support System;
- To suggest a theoretic model for the Lithuanian Real Estate Multiple Listing Service after analysis of application of internet-based electronic systems in real estate sector.

Methods of the Research

Research methods of application of intellectual internet-based electronic systems in real estate sector are based on the analysis of the Lithuanian and foreign scientists' studies in this area. Multiple criteria analysis data processing methods, information technologies, analogies, comparative analysis have been used in the research.

Multiple criteria methods are used to compare real estate alternatives, to calculate both the level of usefulness and market value.

The research is based on scientific and other articles of the Lithuanian and foreign authors, encyclopaedic dictionaries, on-line statistical data of different countries, other scientific and information articles of Lithuanian and foreign educational institutions.

Scientific Novelty of the Research

1. Areas and forms of application of intellectual internet-based electronic systems in real estate sectors were analysed and determined.
2. The developed intellectual electronic systems of real estate were reviewed.
3. The unique Internet-based Real Estate Multiple Criteria Decision Support System was created.
4. Electronic subsystem for calculation of real estate market value was established.
5. An e-mail negotiations system was created.
6. Practical testing of the Internet-based Real Estate Multiple Criteria Decision Support System was executed.
7. On the basis of the analysis of application of information technologies in real estate sector, a theoretic model of Lithuania's Multiple Listing Service for Real Estate was presented.
8. Theoretic results may be useful to pursue further scientific and practical activities.

Theoretic and Practical Results of the Work

1. The information on the application of the Lithuanian and foreign intellectual electronic systems in real estate sector has been reviewed.
2. Areas and forms for application of intellectual electronic systems in practice in real estate sector were determined.
3. Scientific research studies in the sphere of real estate systems were reviewed.
4. Websites on real estate with neural networks, expert systems and decision support systems were reviewed.

5. The Internet-based Real Estate Multiple Criteria Decision Support System was created.
6. The electronic subsystem for calculation of real estate market value was created.
7. An e-mail negotiations system was created.
8. Practical testing of the created Internet-based Real Estate Multiple Criteria Decision Support System was performed.
9. The theoretic model of the Lithuanian Multiple Listing System of Real Estate was suggested.
10. Theoretic work results may be useful to pursue further scientific and practical studies.

Approval of the Research work and practical application of the results

The main propositions of the dissertation have been discussed in local and international scientific conferences and seminars in Germany, Scotland, Poland, Denmark, Belgium, Holland, the USA, Latvia, Russia and Lithuania. The Dissertation materials have been published in seventeen scientific articles. While writing the dissertation, the Internet-based Real Estate Multiple Criteria Decision Support System was created; it is used in the project "European Commission. *Framework-6* Programme on Research, Technological Development and Demonstration 2003. Integrated Project. Intelligent Cities". The Internet-based Real Estate Multiple Criteria Decision Support System is also used in Vilnius Gediminas Technical University, in the following distance study programmes supervised by the Construction Economy and Real Estate Management Departments: Construction Management (Construction Economy and Business Majors) and Real Estate Evaluation and Management (Real Estate Management and Internet Technologies in Real Estate Business Majors).

Volume and Structure of the research

The dissertation consists of the introduction, four chapters, conclusions and suggestions, bibliography and appendixes. The size of the dissertation is 116 pages. The structure of work is provided in Figure 1.

Chapter 1 **"Review of the Information Technologies Practice in Real Estate Sector".** Ranges of application of information technologies in real estate sector are investigated. In this chapter, the means of information technologies, which are applicable in real estate sector, are identified:

- internet,
- real estate e-business,

- real estate e-business systems,
- neural networks,
- expert systems,
- decision support systems.

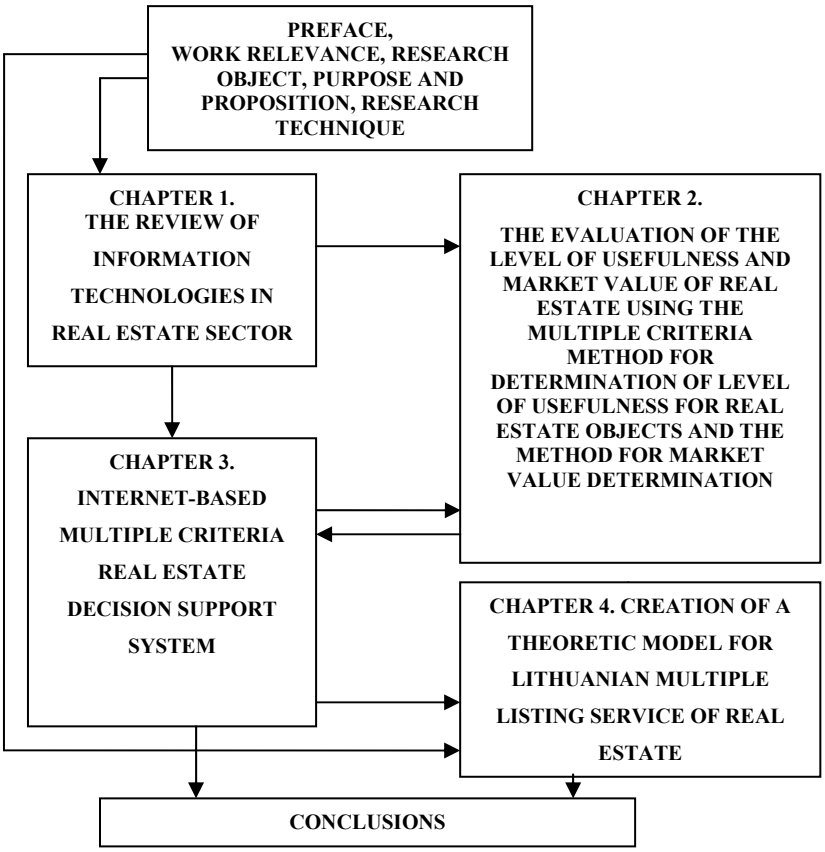


Figure 1. Dissertation structure

The chapter analyses the meaning of application of opportunities provided by Internet in real estate sector as well as opportunities available for an Internet user. At present an ordinary internet user does not possess comprehensive knowledge on real estate sector; however, he may always visit a website of a reliable and solid real estate company with the help of

which he will be able to buy, sell, lease and perform other financial operations with an owned or desirable house, apartment, land or other real estate object. It is all made possible due to the high level of IT and the broad information system, unlimited internet opportunities, accumulated real estate experts' knowledge, experience, mistakes made and achievements, clarity of information as well as simple use. That is precisely what scientists and businessmen who work in real estate sector have been investigating and developing already for several decades.

By analysing real estate e-business systems this chapter is also devoted to real estate e-business. Today powerful information processing systems, which are integrated into websites, are being developed in real estate sector. Such websites are used in business. For this reason internet currently is abounding with real estate internet-based systems as well as real estate multiple listing services integrated with expert systems, neuron networks and decision support systems. Integrated into real estate internet-based systems these systems enable many actions to be accomplished with regard to the owned or desirable real estate. Due to these systems what one has to do is to sit comfortably, enter the web site of a certain company and get all necessary information following short and clear directions. Having calculated and considered several choices, one is capable to select the most optimal one according to personal wishes and financial means.

In addition, this chapter briefly reviews research studies performed in the field of the creation of real estate system as well as analyses real estate websites with integrated expert systems, neural networks and decision support systems.

Chapter 2 titled "Evaluation of Real Estate Efficiency Coefficient and Market Value by Applying Multiple Criteria Methods " provides the methodology for tasks concerning the evaluation of market value of real estate objects and the comparison of real estate alternatives. While comparing real estate alternatives, calculating efficiency coefficient and determining market value, the multiple criteria methods developed by E.K.Zavadskas and A.Kaklauskas were applied:

- an integrated method for the determination of indices' significance taking into consideration their qualitative and quantitative characteristics;
- a method for multiple criteria integrated proportional measurement;
- a method for multiple criteria determination of efficiency coefficient and market value of real estate objects.

The validity of the application of the above methods for comparison of alternatives described in terms of quantitative and qualitative criteria was

reviewed in the studies of E.K.Zavadskas, A.Kaklauskas, V.Malienė, S.Raslanas, A. Banaitis, V.Trinkūnas and N.Lepkova.

While comparing the real estate alternatives and calculating the efficiency coefficient and establishment of market value, it is necessary to normalise and whereupon evaluate the values of indices which characterise the comparative objects. Then it is possible to compare values with different measurement units that characterise the comparative objects, as well as determine the most effective alternatives. Index values normalised during the evaluations of indices are multiplied by their significance. Consequently, the significances of all indices must be inter-coordinated according to their quantitative and qualitative characteristics. The significances of quantitative indices might be inter-coordinated minutely by giving the meanings of quantitative indices in equivalent monetary expression. When the comparison of significances of quantitative indices has been done, the same is performed over the significances of qualitative indices. Hereby all significances of both quantitative and qualitative indices are inter-coordinated.

The ideas of many authors were used while establishing a criteria system, which defines the real estate alternatives. It is associated with the fact that the aims of interest groups as well as the criteria system defining the real estate alternatives are somewhat rather subjective. Therefore, to the effect that the rate of objectivity in this analysis is increased, while working out a criteria system which defines the real estate alternatives some ideas of experts in this field have been invoked.

The criteria system, for instance, might relatively be divided into three subsystems of the first level:

- criteria subsystem defining the influence of macrolevel factors;
- criteria subsystem defining the influence of microlevel factors;
- criteria subsystem defining the influence of interest groups;

The criteria, which are influential to real estate, are divided into quantitative and qualitative. The following are attributed to the quantitative criteria: the total area and the price for square meter. The qualitative criteria are as follows: storey, district, condition of premises, etc.

A decision-making matrix was established to estimate the effectiveness of alternatives for real estate objects under investigation. Having defined this decision-making matrix, a multiple criteria analysis of the alternatives for the real estate objects as well as the calculation of market value was performed. The results of the multiple criteria analysis of the alternatives and the calculation of market value corresponded to the results of the practical testing to have been performed afterwards.

Chapter 3 titled "An Internet-Based Multiple Criteria Real Estate Decision Support System" contains the description of the created Internet-based Multiple Criteria Real Estate Decision Support System (hereinafter IMCREDSS). This system was created on the basis of the analysis of internet-based information systems, expert systems, neural networks, e-commerce systems and decision support systems.

Having analysed the worldwide systems of real estate e-business it was noticed that the majority of them are orientated towards the objectives of economic aims. Therefore, many real estate e-business systems process and provide decisions only with economic information as well as apply economic patterns. The real estate objects under investigation, however, frequently must be evaluated not only in terms of economics but they also must be rated on the basis of qualitative, technical, infrastructure, legal, social and other aspects. Having evaluated the above drawbacks of the systems, the author established the IMCREDSS in which he applied multiple criteria methods allowing real estate objects to be analysed in various aspects.

The IMCREDSS is an information system which collects data and knowledge from various sources, processes them by applying multiple criteria methods, provides the decision-maker with information necessary for the analysis, establishment and evaluation of possible decision alternatives, decision making and outputs and stores the obtained results. In accordance with the data obtained from various sources, the IMCREDSS allows the system users to transform an enormous unprocessed amount of data into informative messages necessary for the analysis of problem being solved and for decision-making.

The IMCREDSS consists of four major components:

- databases (databases, their control system);
- data processing patterns;
- user interface;
- e-mail negotiations system.

Databases. All data regarding objects (descriptions, criteria, references to photographs), criteria applied (names, measurement units, significances) and references (address and description of reference) are kept in the IMCREDSS databases.

A relational database structure that best satisfies the requirements posed by the decision support systems is implemented in the IMCREDSS. Information contained in the relational database is kept in tables. Every table is given a name in which it is stored in the computer external memory as a separate file. Common indices of these tables interconnect them on the basis of logic. All tables connected in this logical way comprise a relational pattern.

Two databases are used in the IMCREDSS. All data on real estate objects are stored in one database. Another database contains all information concerning references, which provide additional useful as well as necessary information for decision-making.

A comprehensive database of objects where quantitative and qualitative evaluations of objects as well as visual information of objects are provided is implemented in the created IMCREDSS. All data are kept and processed by records in the system.

Information in databases is only stored. No operations with data are performed there. Calculations are exercised in the IMCREDSS system data processing module.

Data processing patterns. While establishing the IMCREDSS data processing module, the multiple criteria methods developed by E. K.Zavadskas and A.Kaklauskas have been applied: an integrated method of measuring the significances of indices by considering their qualitative and quantitative characteristics, a method of multiple criteria integrated proportional evaluation and a multiple criteria method of determination of efficiency coefficient and market value of real estate objects. With reference to multiple criteria methods, real estate objects are assessed taking into consideration prices of sold comparative objects, market conjuncture (real estate supply and demand, benevolence of investments, local economic and demographic structures), quantitative (size of the holding and its build-up area, amount and area of belongings, etc.), qualitative (local infrastructure, building condition, shape of the holding, etc.) and legal (various restrictions) factors that characterise objects under investigation. The system of criteria is based on the above factors to quantitatively describe the objects under consideration. After the system of criteria is established, it is necessary to normalise and then evaluate index values that characterise real estate objects in the multiple criteria real estate object selection. Having performed this, one can compare values of indices with different measurement units and define the most effective alternatives, i.e. define the market value of the object under evaluation.

User interface. User interface is one of the most important components of the IMCREDSS systems. Very often the user judges the effectiveness of the system taking into consideration the possibilities of user interface. The user interface helps utilise data and patterns effectively, increases the effectiveness as well as the frequency of utilisation of a definite system. The user interface might be analysed on the basis of its components (work language, presentation language, and knowledge base) and by means of interface.

While developing the IMCREDSS user interface, websites, windows and links between them have been designed and programmed.

E-mail negotiations system. An innovative negotiations e-mail system is installed in the IMCREDSS system. This system allows a negotiating function being performed between the system administrator and the real estate seller. Negotiations are accomplished with the purpose to equalise the prices of real estate objects present in the IMCREDSS system database with the actual prices of real estate objects that prevail in the market.

The created IMCREDSS today makes the user capable of performing the following functions: review of qualitative and quantitative descriptions of real estate objects, search for real estate, presentation of alternatives for real estate objects and drawing comparative tables, multiple criteria analysis of real estate alternatives, determination of market value of real estate object, review of qualitative and quantitative description of insurance companies' services, providing alternatives for insurance services and drawing comparative tables, multiple criteria analysis of alternatives for insurance services, selection of the best alternative for insurance services.

Search. One of the most important components of the IMCREDSS system is search. Search in e-business systems is a tool by means of which a user can quickly find an object that suits him best by clearly defining the criteria of the object being searched for. The user is not only able to see and obtain data in the IMCREDSS system according to the type of real estate or the real estate broker, but he can also find the object he is interested in according to the desired criteria. As distinct from other decision support internet-based systems, the search system implemented in the system provides the user not only with the general information about objects (general description, a photograph) but also presents to the user an expert quantitative and qualitative description of every object. The search system simplifies the usage of the IMCREDSS as well as makes the system more dynamic and flexible.

Currently, the search function of the system allows to access objects according to the type of object, price, size of the holding, built-up area, house area. Having selected “Search” in the main menu, the user enters the window where he/she can specify search conditions. After determining the desired search, the system selects records from the database, which satisfy the search conditions and displays them.

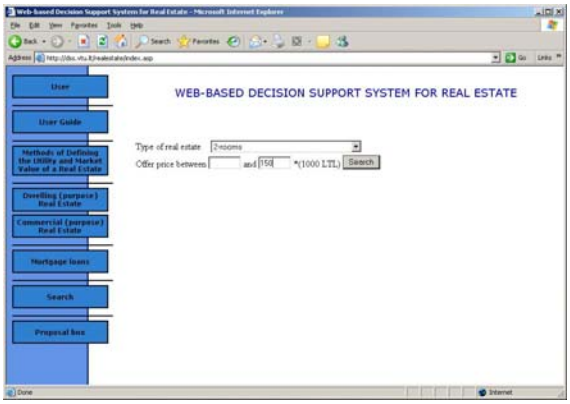


Figure 2. Window for specifying search conditions in the Internet-based Multiple Criteria Real Estate Decision Support System.

Review of real estate objects. A user of the IMCREDSS system is provided with general information on real estate: description of objects that suit criteria specified by the user and a photograph. Information about real estate brokers who offer objects congruous with the search is provided as well. Beside all this information, the user can also see the displayed meanings of selected object criteria. The number of criteria depends upon the type of the object selected.

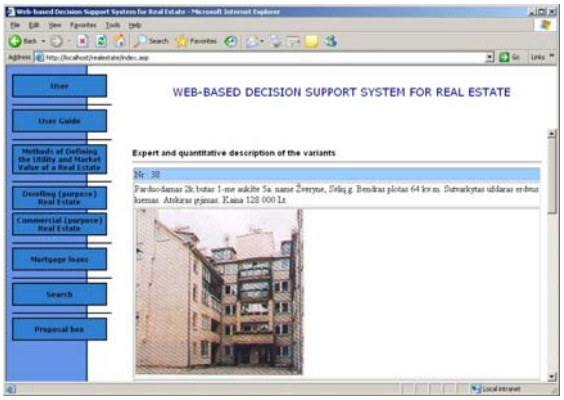
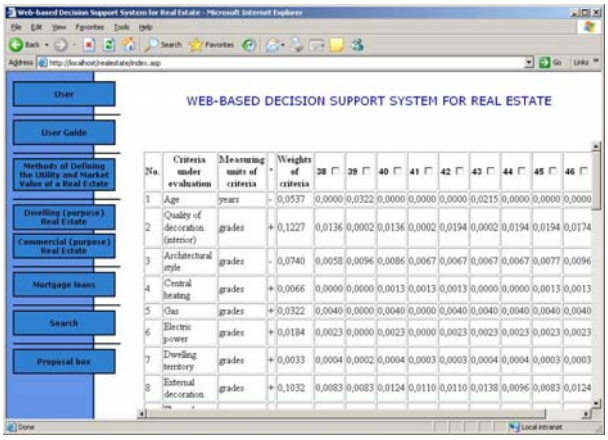


Figure 3. Review of real estate objects

Providing alternatives for real estate objects, drawing of comparative tables and analysis of alternatives. By applying multiple criteria methods the IMCREDSS analyses various alternatives. The system allows the user to compare the selected real estate objects or insurance companies' services according to their descriptive quantitative and qualitative criteria. The system performs a multiple criteria analysis of alternatives and selects the most effective one, i.e. it provides the user with the possibility to model databases variably.

With the intention of performing an analysis of alternatives, the user selects in the IMCREDSS the alternative, which interests him/her the most. Every alternative is described in terms of quantitative and qualitative indices provided in the form of a table in the main page of the system. The top of the table contains an active reference "Results of Multiple Criteria Evaluation". After activating this reference the system automatically performs calculations and answers are displayed on the screen. Answers are provided in the form of a table.

Every answer is assigned to a relative priority. The priority is assigned in conformity with the object efficiency coefficient calculated by means of multiple criteria methods. The object efficiency coefficient is directly dependent on their descriptive criteria system, meanings and significances. All efficiency coefficients of alternatives under investigation range from 0 to 100 per cent.



No.	Criteria under evaluation	Measuring units of criteria	"	Weights of criteria	38	39	40	41	42	43	44	45	46
1	Age	years	-	0,0537	0,0000	0,0322	0,0000	0,0000	0,0000	0,0215	0,0000	0,0000	0,0000
2	Quality of decoration (interior)	grades	+	0,1227	0,0136	0,0002	0,0136	0,0002	0,0194	0,0002	0,0194	0,0194	0,0174
3	Architectural style	grades	-	0,0740	0,0058	0,0096	0,0086	0,0067	0,0067	0,0067	0,0067	0,0077	0,0096
4	Central heating	grades	+	0,0066	0,0000	0,0000	0,0013	0,0013	0,0013	0,0000	0,0000	0,0013	0,0013
5	Gas	grades	+	0,0322	0,0040	0,0000	0,0040	0,0000	0,0040	0,0040	0,0040	0,0040	0,0040
6	Electric power	grades	+	0,0184	0,0023	0,0000	0,0023	0,0000	0,0023	0,0023	0,0023	0,0023	0,0023
7	Dwelling territory	grades	+	0,0033	0,0004	0,0002	0,0004	0,0003	0,0003	0,0004	0,0004	0,0003	0,0003
8	External decoration	grades	+	0,1032	0,0083	0,0083	0,0124	0,0110	0,0110	0,0138	0,0096	0,0083	0,0124

Figure 4. Results of multiple criteria evaluation of real estate alternatives.

Considering the calculations performed by the system, which provides

each answer with a relative superiority with regard to each other, every user using the system can select the answer that suits him the best.

Evaluation of real estate object market value. Having defined an object priority and using the IMCREDSS system one is able to compare the offered price of real estate objects with the market price of the same object. To this end the IMCREDSS system allows the market value price of real estate object to be established additionally. In many cases the evaluation of the real estate object is a unique aspect in the field of real estate. Naturally, the estimator's opinion concerning real estate is of great importance depending on the objective of evaluation, i.e. if property is being evaluated with the intention to sell, insure, entrust, raise a loan, etc. Under market economy conditions, however, it is very important that all market participants were fairly informed and that they properly realised phenomena associated with real estate. Accordingly, relying on multiple criteria methodology as well as accumulated data on sold real estate objects and due to endeavours of special evaluators, the IMCREDSS is capable of evaluating the market value of thereal estate object. Beyond all doubt there is the principal condition for the answer accuracy: number of objects in the database and date of object sale.

When a proper amount of data is available, the electronic evaluation of the market value with the help of the IMCREDSS is highly effective. The real estate objects in the IMCREDSS are being evaluated taking into consideration prices of realised comparative objects. Market value is being evaluated by means of approximation in the system.

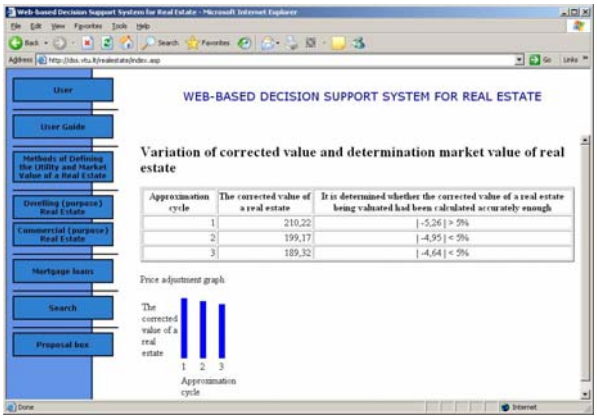


Figure 5. Market value determination

Standard commercially available hardware and software and internet technologies were used to create the IMCREDSS.

The designed IMCREDSS was described in various international and national scientific articles and introduced in many international and national conferences. This system was used in practice in the project "European Commission. 6th Framework Programme on Research, Technological Development and Demonstration 2003. Integrated Project. Intelligent Cities" and in the process of distance studies supervised by the Departments of Construction Economy and of Real Estate Management of Vilnius Gediminas Technical University.

Calculations accomplished using the IMCREDSS system coincided with the manual calculations of comparison of real estate alternatives and of the market value determination in Chapter 2.

Chapter 4 titled "Establishment of Theoretic Model of Lithuanian Multiple Listing Service for Real Estate" identifies the meaning of real estate electronic services and trends of their development.

When the real estate market enlarges and the number of real estate objects increases, the demand for real estate services and new data management tools is constantly growing.

At present it is more essential for the participants of the real estate market to obtain technologies of decision-making than the data on real estate. Currently, when an enormous amount of information must be processed, the possibilities offered by information technologies and intellectual systems, including Internet, may be of the best service for decision support and help users to find information and process it in the workplace.

After the evaluation of the real estate development trends this chapter deals with the possibilities to increase efficiency of real estate electronic services by applying intellectual systems. A theoretic model multiple listing service of real estate with the main objective to control flows of information and to ensure effective decision-making was also introduced. The integral information systems of the real estate multiple listing service were also put forward. Factors influential on the structure and functionality of the real estate multiple listing service were evaluated. Having measured existing technical, legal and commercial conditions, automated real estate services were suggested for the proposed theoretic model of the real estate multiple listing service.

The integrated pattern of real estate multiple listing service comprising database modules and multiple criteria pattern bases was created.

After analysing the effect of external factors which influence real estate multiple listing service in Lithuania, it was stated that the conditions for the

establishment of the real estate multiple listing service are favourable, and the conclusion was made that the creation and implementation of the unified real estate multiple listing service in Lithuania is a significant step in the development of the national electronic services for real estate.

Conclusions

1. Many Property e-Business Systems and Multiple Listing Service systems are processing and submitting only economic information for decisions. Alternatives under consideration have to be evaluated not only from the economic position, but take into consideration qualitative, technical and other characteristics.
2. The multiple criteria methods developed by E.K.Zavadskas and A.Kaklauskas were suggested for dealing with practical tasks concerning the comparison of real estate alternatives as well as the evaluation of the market value of real estate objects;
3. Based on the analysis of existing electronic commerce, information, expert and decision support systems the Internet-based Real Estate Multiple Criteria Decision Support System consisting of a database, database management system, user interface and e-mail negotiations system was developed.
4. By applying e-mail negotiations system it is possible to obtain information that describes property determination of market value.
5. Multiple criteria methods developed by E.K.Zavadskas and A.Kaklauskas were used for the comparison of the Internet-based Real Estate Multiple Criteria Decision Support System alternatives and the evaluation of market value: an integrated method of measuring significances of indices by considering their qualitative and quantitative characteristics, a method of multiple criteria integrated proportional evaluation and a multiple criteria method of determination of efficiency coefficient and market value of real estate objects;
6. The Internet-based Real Estate Multiple Criteria Decision Support System seems to be is a better online system to others, because the module of the database management system enables to analyse the real estate alternatives pursuant to the diverse aspects containing different parameters.
7. By applying the Internet-based Real Estate Multiple Criteria Decision Support System it is possible to obtain quantitative and conceptual information that describes real estate from the point of view of various aspects (i.e. economic, legislative, infrastructural, social, qualitative, technical, technological, etc.).

8. Following such information and with assistance of the Internet-based Real Estate Multiple Criteria Decision Support System system the user is able to perform as follows: the real estate evaluation in different aspects (i.e. determination of market value, value in use), and the determination of the best alternative.
9. The created Internet-based Real Estate Multiple Criteria Decision Support System was tested in practice;
10. The designed Internet-based Real Estate Multiple Criteria Decision Support System was described in various international and national scientific articles and introduced in many international and national conferences. It was used in practice in the project „European Commission. 6th Framework Programme on Research, Technological Development and Demonstration 2003. Integrated Project. Intelligent Cities“;
11. A theoretic model of the Lithuanian real estate multiple listing service was provided.

The List of Scientific Publications On the Doctoral Thesis

In reviewed publications:

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2. A.Kaklauskas, E.K.Zavadskas, M.Gikys, A.Gulbinas. Multiple Criteria Property E-business System. Construction Innovation and Global Competitiveness. The Organization and Management of Construction. Vol. 1,2: 10th international symposium on construction innovation and global competitiveness. Cincinnati, Ohio, September 9 -13, 2002. Cincinnati: Crc Press Inc, Boca Ration, 2003, p. 739-752. **(In ISI Proceedings).**
3. Zavadskas, E.K.; Kaklauskas, A.; Gikys, M.; Lepkova, N.; Kaklauskiene, J. A multiple criteria decision support Web-based system for facilities management. International Journal of Internet and Enterprise Management, Vol. 2, No. 1, 2004, p. 30-44.
4. A.Kaklauskas, M.Gikys. Increasing efficiency of multiple listing service systems applying web-based decision support system for real estate. Journal of Civil Engineering and Management, Vol. XI, No 2. Vilnius: Technika, 2005, p. 91-98.

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8. E.K.Zavadskas, A..Kaklauskas, N.Lepkova, M.Gikys, A.Banaitis. Web-Based Simulation System for Facilities Management ACS'02 - SCM conference, Poland, October 23-25, 2002, p. 514-522.
9. E.K.Zavadskas, A.Kaklauskas, S.Raslanas, M.Gikys, J.Šaparauskas, P.Vainiūnas. A Multiple Criteria Decision Support Web-Based System for Sustainable Urban Development. 20th International Symposium on Automation and Robotics in Construction, September 21-24, 2003. Conference Proceedings. Eindhoven, the Netherlands, September 21-25, 2003, p.295-300.
10. E.K.Zavadskas, A.Kaklauskas, S.Raslanas, M.Gikys, J.Šaparauskas.Web-Based Multiple Criteria Analysis of Sustainable Urban Development Problems. ISEC 2003.Third International Conference on Information Systems and Engineering and Construction. Conference Proceedings. Cocoa Beach, Florida, June 11-13, 2003, 7 p. – 1 CD-ROM.
11. E.K.Zavadskas, A.Kaklauskas, M.Gikys, A.Gulbinas. E - business and Multiple Criteria Analysis. Decision support systems electronic and mobile commerce multicriteria decision aid human centered processes ethical dilemmas in decision making: 12th mini EURO conference / The Association of European Operational Research Societies within INFORS. Vrije Universitteit Brussel. Belgium. April 2-5, 2002.-Brussels, 2002, p. 96.

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12. E.K.Zavadskas, A.Kaklauskas, P.Vainiunas, J.Saparauskas, M.Gikys. Web-Based Decision Support in Sustainable Urban Development. SIID-2003. International Conference on Sustainability Indicators and Intelligent Decisions. Conference Proceedings. 9 - 11 October 2003, Vilnius, Lithuania. p. 51-52.
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14. M.Gikys, A.Gulbinas. Vizualinio dinamiškumo didinimas bei interaktyvumo diegimas distanciniame mokyme.. 7-oji Lietuvos jaunųjų mokslininkų konferencija "Lietuva be mokslo - Lietuva be ateities" Vilniaus Gedimino technikos universitetas. 2004 m. kovo 25-26 d., medžiaga, p.15-20.
15. M.Gikys, A.Gulbinas. Internetinė elektroninė mokymo sistema. 6-oji Lietuvos jaunųjų mokslininkų konferencija "Lietuva be mokslo - Lietuva be ateities" Vilniaus Gedimino technikos universitetas. 2003 m. kovo 27 d. medžiaga, p.32-36.
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Mindaugas Gikys was born in Vilnius, on March 12, 1975.

In 1997 he graduated with the Bachelor‘s Degree of Civil Engineering in the Faculty of Civil Engineering from Vilnius Gediminas Technical University.

In 1999 he graduated with the Master‘s Degree of Construction Management in the Faculty of Civil Engineering from Vilnius Gediminas Technical University. In 1999 – 2001 he worked as an assistant in the Department of Construction Economics and Property Management of Vilnius Gediminas Technical University. In 2001 – 2005 he was a PhD student in the Department of Construction Economics and Property Management of Vilnius Gediminas Technical University. In 1999 – 2003 Mindaugas Gikys was a tutor of distance learning in the Department of Construction Economics and Property Management of Vilnius Gediminas Technical University.

Since 2001 he has been a member of the European Distance Education Network. He has completed his internship in Holland, Germany, Poland, Sweden, Scotland and Finland.

NEKILNOJAMOJO TURTO INTERNETINĖ DAUGIAKRITERINĖ SPRENDIMŲ PARAMOS SISTEMA

Įvadas

Darbo aktualumas

Pastaraisiais metais Lietuvoje nekilnojamojo turto rinka sparčiai auga. Toks spartus šalies nekilnojamojo turto rinkos augimas yra įtakojamas keleto pagrindinių veiksnių: gyventojams atsivėrė plačios skolinimosi galimybės, gerėjanti ekonominė situacija suteikia žmonėms didesnių vilčių ir lūkesčių, pagal apsirūpinimą būstu Lietuva vis dar atsilieka nuo Europos Sąjungos rodiklių beveik dvigubai, paklausai gerokai viršijant pasiūlą atsiveria geros sąlygos statybininkams bei jų produkciją pardavinėjančioms nekilnojamojo turto agentūroms, besiplečianti nekilnojamojo turto rinka traukte traukia investuoti žmones, turinčius laisvų pinigų, auganti infliacija šalyje ir kt.

Dėl rinkos plėtros ir išaugusios konkurencijos, informacinių technologijų integracija į nekilnojamojo turto sektorių šiandiena yra reikalinga labiau nei bet kada anksčiau. Informacinių technologijų ir telekomunikacijų panaudojimas nekilnojamojo turto sektoriuje užtikrina spartesnį informacijos apsikeitimą tarp visų suinteresuotų grupių ir leidžia efektyviau reaguoti į rinkos pokyčius.

Šiandiena informacinių technologijų ir telekomunikacijų pritaikymo nekilnojamojo turto versle sritis – internetas. Pasitelkus internetą bet kokioje veikloje, yra sudaromos galimybės įveikti laiką ir erdvę. Naudodamiesi internetu, mes galime laisvai gauti gana daug ir išsamios informacijos apie nekilnojamąjį turtą. Tačiau tuo šiandieninės interneto teikiamos galimybės neapsiriboja. Dažnai įvairūs tinkalapiai apie nekilnojamąjį turtą mums suteikia galimybę nuotoliniu būdu pasinaudoti verslo ekspertų konsultacijomis, patarimais, ekspertiniais vertinimais ir kt. Taip pat, labai dažnai intertenete mes galime naudotis įvairiomis nekilnojamojo turto elektroninio verslo sistemomis, kurios leidžia atlikti prekių, paslaugų ir informacijos pirkimą ir pardavimą, bendravimą su partneriais, sandorių sudarymą elektroniniu būdu ar kitokį verslo palaikymą naudojant elektroninę infrastruktūrą.

Šiuo metu pasaulyje yra sukurta daug nekilnojamojo turto elektroninio verslo sistemų. Šios nekilnojamojo turto elektroninio verslo sistemos teikia informaciją ir iš dalies paslaugas tokiose srityse: nekilnojamojo turto pardavimas, pirkimas, nuoma, įvairios paieškos, įvairūs patarimai ir informacija apie nekilnojamojo turto nuomą, jos planavimą, išsami informacija apie užstatus, paskolas, draudimo paslaugos, įsikurimas naujoje

vietoje, patyrusių nuomininkų patarimai pradedantiesiems, lizingo paslaugos, informacija apie persikėlimą į naują gyvenamąją vietą, pastatų ūkio valdymo paslaugos, įvairūs skelbimai, kita pažintinė informacija.

Šiandiena pažangiausiose elektroninio verslo sistemose ir nekilnojamojo turto daugiafunkcinėse paieškos sistemose pateikiama visa išsami informaciją apie nekilnojamąjį turtą ir jo aplinką taip, kad sistemų vartotojai gautų visą norimą informaciją neatsitraukdami nuo kompiuterių. Tokiose nekilnojamojo turto elektroninio verslo sistemose vartotojams yra teikiamos šios nekilnojamojo turto elektroninės paslaugos: nekilnojamojo turto paieška, draudimo bendrovių paslaugų peržiūra, draudimo paslaugų alternatyvų analizė, automatizuotos geografinių informacinių sistemų paslaugos, nekilnojamojo turto objekto demonstravimas elektroniniu tinklu, elektroninės reklaminės informacijos apie nekilnojamąjį turtą pateikimas, potencialių pirkėjų atrinkimas saugumo sumetimais, pastatų ūkio valdymo paslaugos, pagalba pirkimo-pardavimo derybose ir kt..

Vystantis Lietuvos ekonomikai, aktyvėjant nekilnojamojo turto rinkai bei plečiantis informacinių technologijų ir telekomunikacijų panaudojimo galimybėms, internetinių elektroninių sistemų taikymo nekilnojamojo turto sektoriuje tyrimas yra labai aktualus statybos mokslo objektas.

Tyrimo objektas

Tyrimo objektą sudaro intelektualių internetinių elektroninių sistemų taikymas nekilnojamojo turto sektoriuje.

Tyrimo tikslas ir uždaviniai

Pagrindinis tyrimo tikslas – sukurti internetinę nekilnojamojo turto daugiakriterinę sprendimų paramos sistemą ir pasiūlyti šią sistemą apimantį Lietuvos nekilnojamojo turto daugiafunkcinės paieškos sistemos teorinį modelį.

Siekiant keliamo tikslo sprendžiami tokie uždaviniai:

- nustatyti intelektualių internetinių elektroninių sistemų taikymo nekilnojamo turto sektoriuje sritis ir formas;
- apžvelgti pasaulio šalių nekilnojamojo turto sektoriuje taikomas intelektualias internetines elektronines sistemas, kuriose taikomi neuroniniai tinklai, ekspertinės sistemos ir sprendimų paramos sistemos;
- sukurti internetinę nekilnojamojo turto daugiakriterinę sprendimų paramos sistemą;
- sukurti ir įdiegti internetinėje nekilnojamojo turto daugiakriterinėje sprendimų paramos sistemoje elektroninę nekilnojamojo turto rinkos vertės skaičiavimo posistemę;

- sukurti ir įdiegti internetinėje nekilnojamojo turto daugiakriterinėje sprendimų paramos sistemoje elektroninio pašto derybinę sistemą;
- atlikus internetinių elektroninių sistemų taikymo nekilnojamojo turto sektoriuje analizę, pasiūlyti Lietuvos nekilnojamojo turto daugiafunkcinės paieškos sistemos teorinį modelį.

Tyrimų metodika

Intelektualių internetinių elektroninių sistemų taikymo nekilnojamojo turto sektoriuje tyrimo metodika paremta Lietuvos ir užsienio šalių mokslininkų šioje srityje darbų analize. Atliktiems tyrimams pritaikyti daugiakriterinės analizės duomenų apdorojimo metodai, informacinės technologijos, analogijos principai, palyginamoji analizė.
Nekilnojamojo turto alternatyvų palyginimui, naudingumo laipsnio skaičiavimui ir rinkos vertės nustatymui taikomi daugiakriteriniai metodai.
Rengiant darbą remtasi Lietuvos ir užsienio autorių mokslinėmis ir kitomis publikacijomis, enciklopediniais žinynais, įvairių šalių statistiniais duomenimis internete, kitais Lietuvos ir užsienio mokslo institucijų moksliniais ir informaciniais leidiniais.

Mokslinis darbo naujumas

1. Ištirtos ir nustatytos intelektualių internetinių elektroninių sistemų taikymo nekilnojamojo turto sektoriuje sritys bei formos;
2. Apžvelgtos sukurtos intelektinės internetinės elektroninės nekilnojamojo turto sistemos;
3. Pasiūlyta ir sukurta pasaulyje analogų neturinti internetinė nekilnojamojo turto daugiakriterinė sprendimų paramos sistema;
4. Sukurta elektroninė nekilnojamojo turto rinkos vertės skaičiavimo posistemė;
5. Sukurta elektroninio pašto derybinė sistema;
6. Atliktas sukurtos internetinės nekilnojamojo turto daugiakriterinės sprendimų paramos sistemos praktinis testavimas;
7. Remiantis informacinių technologijų taikymo nekilnojamojo turto sektoriuje analize, pasiūlytas Lietuvos nekilnojamojo turto daugiafunkcinės paieškos sistemos teorinis modelis;
8. Teoriniai darbo rezultatai gali būti naudingi tolesniems moksliniams ir praktiniams darbams vykdyti.

Teoriniai ir praktiniai darbo rezultatai

1. Atlikta Lietuvos ir užsienio šalių intelektualių internetinių elektroninių sistemų taikymo nekilnojamo turto sektoriuje informacijos apžvalga.

2. Nustatytos intelektualių internetinių elektroninių sistemų taikymo nekilnojamojo turto sektoriuje srytys bei formos.
3. Atlikta mokslinių tyrinėjimų nekilnojamojo turto sistemų srityje apžvalga.
4. Atlikta nekilnojamojo turto internetinių tinklalapių, kuriuose taikomi neuroniniai tinklai, ekspertinės sistemos ir sprendimų paramos sistemos, apžvalga.
5. Sukurta internetinė nekilnojamojo turto daugiakriterinė sprendimų paramos sistema.
6. Sukurta elektroninė nekilnojamojo turto rinkos vertės skaičiavimo posistemė.
7. Sukurta elektroninio pašto derybinė sistema.
8. Atliktas sukurtos internetinės nekilnojamojo turto daugiakriterinės sprendimų paramos sistemos praktinis testavimas.
9. Pasiūlytas Lietuvos nekilnojamojo turto daugiafunkcinės paieškos sistemos teorinis modelis.
10. Teoriniai darbo rezultatai gali būti naudingi tolesniems moksliniams ir praktiniams darbams vykdyti.

Darbo aprobavimas ir praktinis rezultatų naudojimas

Pagrindiniai disertacinio darbo teiginiai buvo aptarti tarptautinėse ir respublikinėse mokslinėse konferencijose ir seminaruose Vokietijoje, Škotijoje, Lenkijoje, Danijoje, Belgijoje, Olandijoje, JAV, Latvijoje, Rusijoje ir Lietuvoje. Darbe išdėstyta medžiaga skelbta septyniolikoje mokslo straipsnių. Disertacinio darbo metu sukurta internetinė nekilnojamojo turto daugiakriterinė sprendimų paramos sistema naudojama vykdant projektą „European Commission. 6th Framework Programme on Research, Technological Development and Demonstration 2003. Integrated Project. Inteligent Cities“. Taip pat, internetinė nekilnojamojo turto daugiakriterinė sprendimų paramos sistema naudojama Vilniaus Gedimino technikos universiteto Statybos ekonomikos ir nekilnojamojo turto vadybos katedros kuruojamose nuotolinių studijų programose: statybos valdymas (statybos ekonomikos ir verslo specializacijoje) ir nekilnojamojo turto vertinimas ir valdymas (nekilnojamojo turto valdymo bei internetinių technologijų ir nekilnojamojo turto verslo specializacijose).

Darbo išvados

1. Daugelis nekilnojamojo turto elektroninio verslo sistemų bei daugiafunkcinių nekilnojamojo turto sistemų yra orientuojamos ekonominių tikslų siekiams bei taikydamos ekonominius modelius, teikia sprendimams tik ekonominę informaciją. Tačiau nagrinėjamus

nekilnojamojo turto objektus dažnai reikia vertinti ne tik ekonominiu požiūriu, bet ir įvertinti remiantis kokybiniais, techniniais, infrastruktūriniais, teisiniais, socialiniais ir kitokiais aspektais.

2 Išspręstas praktinis nekilnojamojo turto objektų palyginimo bei rinkos vertės nustatymo uždavinys, taikant E.K.Zavadsko ir A.Kaklausko sukurtus daugiakriterinius metodus;

3. Remiantis nekilnojamojo turto elektroninio verslo sistemų, ekspertinių sistemų, sprendimų paramos sistemų analize, sukurta nekilnojamojo turto internetinė daugiakriterinė sprendimų paramos sistema kuri susideda iš šių dalių: duomenų bazės, duomenų apdorojimo modeliai, vartotojo sąsaja ir derybinė elektroninio pašto sistema.

4. Derybinė elektroninio pašto sistema leidžia nekilnojamojo turto internetinės daugiakriterinės sprendimų paramos sistemos duomenų bazėje esančių nekilnojamojo turto objektų kainas priartinti prie realių rinkoje dominuojančių nekilnojamojo turto kainų.

5. INTDSPS alternatyvų palyginimui bei rinkos vertės nustatymui integruoti E.K.Zavadsko ir A.Kaklausko sukurti daugiakriteriniai metodai: kompleksinis rodiklių reikšmingumo nustatymo, atsižvelgiant į jų kokybines ir kiekybines charakteristikas metodas, daugiakriterinio kompleksinio proporcingo įvertinimo metodas ir daugiakriterinis nekilnojamojo turto objektų naudingumo laipsnio ir rinkos vertės nustatymo metodas.

6. Sukurtos nekilnojamojo turto internetinės daugiakriterinės sprendimų paramos sistemos pranašumas prieš kitas sprendimų paramos sistemas yra tas, kad jos duomenų apdorojimo modulis leidžia analizuoti nekilnojamojo turto alternatyvas įvairiais skirtingus parametrus turinčiais aspektais.

7. Naudojantis nekilnojamojo turto internetine daugiakriterine sprendimų paramos sistema galima gauti nekilnojamąjį turtą iš įvairių aspektų aprašančią kiekybinę ir kokybinę informaciją.

8. Nekilnojamojo turto internetinė daugiakriterinė sprendimų paramos sistema, įvertindama ekonominius, teisinius, infrastruktūrinius, socialinius, kokybinius, techninius, technologinius ir kt. aspektus, gali atlikti nekilnojamojo turto rinkos įvertinimą bei geriausios alternatyvos skaičiavimą.

9. Atliktas sukurtos internetinės nekilnojamojo turto daugiakriterinės sprendimų paramos sistemos praktinis testavimas;

10. Sukurta INTDSPS yra aprašyta įvairiuose tarptautiniuose bei šalies moksliniuose straipsniuose, pristatyta daugelyje tarptautinių ir nacionalinių konferencijų bei praktikoje buvo naudojama vykdant projektą „European Commission. 6th Framework Programme on

Research, Technological Development and Demonstration 2003. Integrated Project. Inteligent Cities“;

11. Pasiūlytas nekilnojamojo turto daugiafunkcinės paieškos sistemos teorinis modelis.

Trumpai apie autorių

Mindaugas Gikys gimė 1975 m. kovo 12 d. Vilniuje.

1997 m. įgijo statybos bakalauro, o 1999 m. statybos valdymo mokslo magistro laipsnį Vilniaus Gedimino technikos universitete, Statybos fakultete. 1999 – 2001 m. dirbo asistentu Vilniaus Gedimino technikos universiteto Statybos ekonomikos ir nekilnojamojo turto vadybos katedroje.

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Nuo 2001 m. Europos distancinio mokymo tinklo (EDEN) narys. Stažavosi Olandijoje, Vokietijoje, Lenkijoje, Škotijoje, Suomijoje.

Padėka

Norėčiau padėkoti darbo vadovui prof. habil. dr. A.Kaklauskui ir VGTU pirmąjam prorektoriui prof. habil. dr. E.K. Zavadskui už neįkainojamą pagalbą bei patarimus rašant šį darbą. Dėkui visiems Statybos ekonomikos ir nekilnojamojo turto vadybos katedros darbuotojams už palaikymą ir pagalbą sprendžiant iškilusias problemas.

Taip pat norėčiau širdingai padėkoti savo artimiesiems už kantrybę ir supratimą.

Mindaugas Gikys
NEKILNOJAMOJO TURTO INTERNETINĖ DAUGIAKRITERINĖ SPRENDIMŲ PARAMOS SISTEMA

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Mindaugas Gikys
INTERNET-BASED REAL ESTATE MULTIPLE CRITERIA DECISION SUPPORT SYSTEM

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